BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

SECOND SEMESTER 2020-2021

EEE F243 / INSTR F243 - Signals and Systems

MATLAB-BASED ASSIGNMENT: Open Book

Max Marks: 20 **Due Date: 15-04-2021 (Due by 5 pm)** **Date: 09-04-2021**

Instructions: Please make sure you add a title, axis labels, x-axis limit and y-axis limit, and legend (if required) to each of your figures. The marks will be deducted if the figures are not clear and/or any of these are not mentioned.

You need to save the MATLAB code and the figure in a TIFF format.

1a) Generate a signal $x(t)$ with total duration of 5 ms (0 to 5 ms), in which the first 3 ms (i.e., 0 to 3 ms) there is a single tone sinusoidal $x_1(t) = Acos(2\pi f\, t)$, where A (signal amplitude) = 5volts, and the last 2 ms of the total duration, the signal is zero. Use the sampling frequency (Fs) = 800 kHz and the frequency (f) of the signal is 1**XXX** (where, **XXX** is the last three digits of your BITS ID number, that is, if the ID is 2020A3PS0123P, then the frequency = 1123Hz).

1b) Now, a new signal $x_1(t) = x(-\frac{t}{2} + \boldsymbol{b})$ is generated, where $x(t)$ is the same as in 1a) and the constant $\boldsymbol{b}$ (in ms) is the last digit of your BITS ID number. For the above ID number, $\boldsymbol{b}$ = 3. However, based on your ID number if $\boldsymbol{b}$ = 0, then select $\boldsymbol{b}$ = 9.

Plot the signals $x(t), x(t+b)$ and $x_1(t)$ as a function of time. Show the results as subplots of 3x1. **(5M)**

2) A real signal $x(t)$ has its zeros at -2.5 and 2 and poles at –**X**, and (–**Y** + j2), respectively. The values **X** and **Y** are the last two digits of your BITS ID number, respectively. If the ID is 2020A3PS0123P, then **X** = 2 and **Y** = 3. Draw the pole-zero diagram for the complete signal $x(t)$ in the s-plane. Identify which sided signal $x(t)$ would be if ROC had to include the right side of the pole located at -**X**? Justify your answer. (**5M)**

3) Compute the convolution of two rectangular pulses that are described below:

$x_1(t) = u(t+0.3) - u(t-0.1\boldsymbol{t_1})$ and $x_2(t) = u(t+0.5) - u(t-0.1\boldsymbol{t_2})$

Where, $\boldsymbol{t_1}$ and $\boldsymbol{t_2}$ are the last two digits of your BITS ID number, respectively. If the ID is 2020A3PS0123P, then $\boldsymbol{t_1}$ = 2 and $\boldsymbol{t_2}$ = 3. For $x_1(t)$ and $x_2(t)$, the time vector (t) = -1: 0.001: 1.

Plot $x_1(t)$, $x_2(t)$ and $y(t)$ as subplots of 3x1, where $y(t) = x_1(t) * x_2(t)$ and $*$ symbol denotes convolution. Specify the XY coordinates (i.e., x and y values) wherever you observe any change in the shape of $y(t)$. **(5M)**

4) We need to design the **N**th order Butterworth low-pass filter, whose cut-off frequency is 1 rad/sec. Determine the following:

(i) Draw the pole-zero diagram in the s-plane for the system function B(s) of the filter.

(ii) Draw the pole-zero diagram in the s-plane for the B(s)B(-s).

(iii) Compute the system function B(s). Note that your MATLAB code should display the expression for the system function and write down the same answer in your report.

Note that the **N** is the last digit of your BITS ID number. For example, if the ID is 2020A3PS0123P, then **N = 3**. However; based on your ID number: (a) if **N** is **0** then use **N = 10**, **(b)** if **N** is **1** then use **N = 6**. **(5M)**